REMARKS/ARGUMENTS

This amendment responds to the Office Action dated October 2, 2006.

The applicant has amended independent claims 1, 5, 12, and 20 for clarity. The nature of these clarifying amendments is described more fully below beginning in the concluding paragraph of section IIa and continuing into the first few pages of section IIb (up to page 20).

I. Rejections based on anticipation

The examiner rejected claims 20 and 22 under 35 U.S.C. § 102(b) as being anticipated by Kakutani, U.S. Patent No. 5,553,166. Referring to claim 20, the examiner states, and applicant agrees, that Kakutani's "binary coding means" (FIG. 2, item 36) is a "thresholding unit" in accordance with paragraph (a) of claim 20. This coding means does compare a selected threshold intensity with the intensity of a current pixel (this current pixel being first corrected or augmented by accumulated error information in both Kakutani's and applicant's system).

But where does this threshold intensity or value come from? What determines or controls it? The examiner states that in Kakutani this threshold intensity is selected "in response to an accumulated error" for at least one of said current pixel and a pixel neighboring said current pixel (see page 3 of examiner's Action in section discussing paragraph (b) of claim 20). However, FIG. 2 of Kakutani shows no path from its error output (e.g., the output of diffused error storage means 42) to the input of threshold value setting means 32 (a path of such type is shown in applicant's FIG. 5, which extends from the output of error buffer 96 to the input of threshold selection unit 112).

In fact, the threshold value setting means 32 of Kakutani does not select a threshold "in response" to an accumulated error but rather "in response" to the present pixel value or "data(i,j)." This is clear from equation 1 (page 8 of Kakutani) showing the threshold value "Slsh" for a given i,j position as a function of the pixel data for the same position (i.e., data(i,j)). This is also clear from FIG. 2 of Kakutani which shows the output of the image data source 10 feeding directly to the input of the threshold value setting means 32 (compare applicant's FIG. 5 where pixel input 92 does not feed into threshold selection unit 112).

On page 2 of the examiner's Action, the examiner makes the related statement that "the intensity thresholds are based on the error values" and refers to FIG. 6 of Kakutani for support. What FIG. 6 shows is that an "average binary coding" error (as calculated for a string of pixels, not just as individually accumulated for each pixel) changes in response to different selections for the "constant" K in equation 1. But just because the average coding error (versus pixel-by-pixel accumulated error) changes in response to changes in K, doesn't mean that K changes in response to changes in average coding error. To think otherwise is to confuse cause and effect, that is, to slip into a logical fallacy. It is akin to saying that if an early frost caused Florida oranges to go bad, then Florida oranges going bad caused an early frost. K is, after all, a "constant," and once preset for a particular FIG. 2 system, doesn't change (Kakutani, column 8, line 34). There is no mechanism shown or implied in Kakutani for converting the average coding error (or, for that matter, the accumulated errors provided at the output of the error storage means 42, see FIG. 2 of Kakutani) into different values of K.

This conclusion can also be drawn upon further consideration of FIG. 6 of Kakutani. In FIG. 6, the independent or x variable is the value or intensity of the original image data. In constructing FIG. 6, this input data is assumed to be uniform, for example, some constant value, while the dependent or y-axis value, the average binary coding error, is being measured. Let us say the image value equals 4 (e.g., corresponding to a very light gray square). Let us also say that K equals 2 so that the threshold value, Slsh, equals (4 + 128)/2 or 66 (in accordance with equation 1, which also equates, for K=2, to the second formula down on the left of FIG. 6). Referring, then, to the dotted line in FIG. 6 corresponding to K equals 2 (extending at about 45 degrees), we can see that if we operate the system of FIG. 2 long enough (over enough of the uniformly light gray pixels), the average binary coding error will settle at about 100. (If one moves along a vertical line upward from the image data value 4 until intersecting the dotted line and then moves along a horizontal line leftward until intersecting the "average" coding error axis, one obtains the average coding error, which is about 100.) If we then "change" K (K is, in fact, a constant preset for any given system, but let's assume we switch to a different system), say to K equals 4, we move to the next lower line so that, if the image data (x-axis) still equals 4, the average binary coding error (y-axis) now equals about 32. In this sense, then, the average coding error changes in response to a change in K. However, the reverse is not true; K does not change

because of a change in the average coding error. For example, we can shift along the K equals 2 (45 degree) dotted line by shifting the input data value, say from 4 to 32, and the average coding error changes (eventually) from 100 to 75, but all the while K stays the same.

The nondependence of the threshold value on the average binary coding error in Kakutani is even clearer in analogous FIG. 5 where the threshold value, Slsh, is fixed at a constant value of 128 (the results shown in FIG. 5 were obtained with the threshold value setting means 32 removed, see column 10, lines 4-5). In FIG. 5, the average coding error, or dependent variable, is seen to take on different values for different ones (at recurring values) of the input pixel data, or independent variable. In short, the "average binary coding" error that Kakutani mentions is only a result and not a cause of system operation.

In the Action, the examiner implies that in Kakutani, since the selected threshold value relates to the present pixel value, it must also relate to a particular average coding error value. However, to equate the instantaneous value of the present pixel with a particular instantaneous value of average coding error misinterprets Kakutani. Referring to FIG. 5 or 6 of Kakuntani, the independent or x-axis variable, the pixel value, changes instantly with each change in pixel string value, but the dependent or y-axis variable, the average coding error, doesn't reach a stable value reflecting this change until after a sufficient string of pixels identified with this new final error value have been tallied. The time scale of the independent variable, then, is properly taken to be a recurring time scale while the timeframe of the dependent variable is long-term. The threshold value in Kakutani changes the instant the pixel value changes (and takes as many possible values) but the resulting transitional changes in the average coding error as it drifts towards its new stable value has no effect on this new threshold value.

If we consider Kakutani from the standpoint of its broader teaching, we find nothing leading directly or by implication to applicant's claimed system. Kakutani is concerned with two problems: 1) eliminating delays in high-density or low-density dot production when the input data first transitions to regions of dark gray or light gray, respectively, and 2) fixing the problem of "tailing" of a high-density dot pattern into a low-density area, or vice versa (see column 1, lines 53-64; column 9, lines 58-61; and compare FIG. 12's exemplary output to the less desirable output of FIG. 14(A), both being a binary dot representation of the FIG. 13 input). Kakutani notes that a solution to these two problems was contained in a Japanese Patent Application, but

that this solution, which randomly varied the threshold value within a wide range that depended on the value of the input data, introduced "exceptionally high noise" (see column 2, lines 40-62). Kakutani's solution was to confine the range to more constricted limits as defined by equation 6 of column 12 (or, in its most general form, equation 8 of column 15).

Equation 1 of Kakutani is really just a specific application in which each input pixel or data value defines a particular threshold value, these threshold values falling within the limited range defined by equation 6. Alternatively, Kakutani notes there are alternative functions besides equation 1 which meet the prescribed limits of equation 6. These are shown, in FIGS. 8, 9, and 10, as graphs in which the threshold value (y-axis or dependent variable) is shown as a function of the current pixel or data value (x-axis or independent variable). Kakutani is careful to note that each threshold value (at least near the critical input values of 1, 2, 253, and 254) falls within the range prescribed by equation 6 (see column 14, lines 25-28 and lines 50-53). Kakutani even suggests that a small amount of random noise can be added to each threshold value if the original image is "exceptionally systematic" (e.g., of one tone only) to protect against "regular pattern" artifacts (column 15, lines 16-26).

In every one of its embodiments, then, Kakutani assumes that the threshold value selected for position (i,j) will depend, in some fashion, on the input pixel or data value at position (i,j). This is done so that equation 6 can be satisfied and so that the average error (which was perceived as causing the two basic problems) can be kept below the magic number of 50 (column 11, lines 61-64 and column 12, lines 18-20). Kakutani in no way suggests, in accordance with applicant's teaching, that there is any reason to relate the threshold value for position (i,j) not to the present pixel or input data (i,j) but rather to the error value at (i,j) or neighboring positions. (see, for example, paragraphs 0026 and 0028 of applicant's corresponding patent publication, U.S. Pat. Pub. 2002/0196484). In reference to the specific language of paragraph (b) of claim 20, Kakutani simply doesn't show a threshold selection unit selecting a threshold intensity "in response to an accumulated error" for at least one of said current pixel and a pixel neighboring said current pixel.

Based on the foregoing remarks, it is submitted that applicant has overcome the examiner's rejection of claim 20 for anticipation by Kakutani. There being no other rejection entered against claim 20, it is further submitted that this independent claim, together with its

dependent claims 21-22, presently stands in condition for allowance, which action is respectfully requested.

II. Rejections based on obviousness

a. General comment, brief survey, and clarifying amendments

The examiner rejects claims 1-19 and 21 for obviousness over primary reference Kakutani in various combinations with one or more secondary references including Satou (US Pat. 5,159,471), Ostromoukhov (US Pat. 6,356,362 B1), Harrington (US Pat. 6,072,591), and Zlotnick (US Pat. 6,351,566 B1). The various combinations will be further described and considered below, but first applicant deems it worthwhile 1) to make a general comment about the prosecution record thus far; 2) to briefly survey the related significance of certain of these references; and 3) to make two clarifying amendments helpful in view of this survey.

It is perhaps unfortunate that, in claiming the invention, the term "accumulated error" was selected for lack of a better word. If the prosecution record compiled thus far demonstrates anything, it is that in the halftoning art, the term "accumulated" is a ubiquitous and convenient term that is turned this way or that to identify very different things. It is instructive, therefore, to briefly survey the common types of errors that may be imputed to halftoning systems.

First, there is system or ***"conversion" error*** that inherently occurs when a halftoning system converts a multilevel input pixel into a (typically) binary output pixel. For example, when an input pixel having a gray (or color component) tone of 120 (on a scale of 0-255) is converted to a white pixel (deemed to be at 0 on the same scale) the conversion error is 120. Likewise, if an input pixel having a tone of 239 is converted to a black pixel (deemed to be at 255) the conversion error is -16.

Second, there are ***"diffused"*** (or distributed) ***errors*** occurring when a halftoning system "diffuses" or divides a conversion error appearing with a current pixel among neighboring pixels as a means of accounting locally for (and enabling later removal of) this conversion error. Thus a conversion error of -16 for the present pixel might be diffused to neighboring pixels in accordance with predetermined percentages (e.g., see FIG. 1 of applicant's drawings that depicts

the prior art). It may be noted that each of these diffused errors is identified with a corresponding particular pixel.

Third, there are **"accumulated" errors** occurring when diffused errors from an earlier-appearing conversion error are recalculated to account for diffused errors from a later-appearing conversion error. The resulting accumulated errors are ***recalculated pixel-by-pixel***, that is, an earlier diffused error and a later diffused error are only combined or accumulated when the corresponding pixel associated with each is the same. When applicant uses the term "accumulated error," it is used in this conventional sense, that is, in the sense of a diffused error identified with a particular pixel subject to recalculation or accumulation upon additional appearances of conversion error. Conventionally, respective ones of accumulated errors are tabulated (organized into at least a 2-dimensional table of plural rows and columns) for identification with corresponding ones of the individual pixels (as shown with error buffer 96 in FIG. 5 of applicant's drawings).

Applicant is not asserting that the use of "accumulated errors," as understood in the above conventional sense, is novel in and of itself. Indeed, applicant's specification notes that such use has been known since at least 1976, the date of Floyd and Steinberg's landmark paper on the subject (see paragraphs 006 and 007 of applicant's corresponding U.S. Pat. Pub. 2002/0196484 A1). What ***is*** considered a significant contribution by applicant is the use of such accumulated errors in the input-to-output pixel conversion step not just to augment the current input pixel (the traditional approach) but also to select at least one particular threshold value for comparing with the current input pixel. Thus, in FIG. 2 of Kakutani, we find an accumulated error (total_err (i,j)) added to the input pixel (data(i,j)) by data correction means 38, but this same accumulated error is not likewise fed to the "threshold value setting means" 32. In applicant's system, in contrast, as shown in FIG. 2, the accumulated error $e_{0,0}$ is not only added to the current input pixel 92 (the traditional approach) but is also applied, without further processing (and preferably with other accumulated errors $e_{0,-1}$, $e_{0,1}$, $e_{0,-2}$, $e_{0,2}$, and so on; see FIG. 4) as a control input to the threshold selection unit 112.

Taken by itself, the "accumulated error" for a particular pixel provides a measure of how much unresolved error is contained in the pixels neighboring that particular pixel, and applicant's contribution includes pointing out the desirability of directly applying this measure to select at

least one predetermined threshold for the current pixel in the input/output conversion (comparator) step (see paragraph 0026 of applicant's corresponding U.S. Pat. Pub. 2002/0196484 A1). Hence the conversion step is not only more likely to generate an output value that will partially cancel or reverse the current conversion error (due to the traditional approach of augmenting the current input pixel with the corresponding accumulated error) but also this step is more likely to select that one of the output values (minimum or maximum) that best resolves the previous conversion errors diffused from neighboring pixels. A system as shown in FIG. 7 of Ostromoukhov, which provides the augmented pixel value (combining the current pixel value with the corresponding accumulated error value) not only as the primary input value to the comparator 17 (the traditional approach) but also as a control for selecting a (randomly variable not predetermined) threshold, obscures the significance of this measure (because the pixel's current value can generally take on any possible value without relation to previous conversion error) and necessitates further modifications (not shown in Ostromoukhov) to operate in the manner of applicant's claimed system.

A fourth type of halftoning system error is the **"average binary coding error"** referred to in Kakutani (e.g., FIGS. 5 and 6). This average binary coding error appears to relate to the "volume" of accumulation (final value) reached, on average, by each accumulated error, after all accumulations (recalculations) have been considered (see column 10, lines 30-36 and lines 40-50 of Kakutani). Though it is derived from "accumulated errors," it is not itself an accumulated error in the sense used above, that is, it is not identified with a particular pixel and is ***not recalculated pixel-by-pixel***. At best, the average binary coding error is recalculated as an average ***for a group of pixels*** each one of which is identified with an accumulated error that has reached its final value. Normally, however, the average binary coding error is more simply calculated ***without continued reference to any particular pixels*** as a system-level running average of the undistributed "***conversion***" error (the term "binary coding" is just another way of saying conversion).

A fifth type of halftoning system error might be termed **"probable error."** This is like conversion error but less precise. This type of error (under the name "intermediate data") is employed, for example, in the system shown in FIG. 7 of Satou. In FIG. 7, if the input pixel value exceeds threshold A, then the selection circuit 30 selects comparator A to allow maximum

output value; likewise, if the input pixel falls below threshold B, then the selection circuit 30 selects comparator B to allow minimum output value (in each case, the input value is deemed "close enough" to the resulting maximum or minimum output value). However, if the input pixel value is midway between threshold A and B, though a minimum output value is selected by default, the processing circuit 28 outputs a "1" signifying probable error (in the sense that a probable error exists between the midtone input pixel and the minimum value output pixel; note this probable error is not precisely specified like a conversion error would be). This "1" is retained in the shift register 29 until the corresponding pixel on the next line is evaluated, whereupon it is fed to the selection circuit 30 to indicate the probable error. The selection circuit then automatically selects comparator B thus, in effect, allowing a lower value input pixel to produce a maximum output value (so as to compensate for the above pixel in which a midvalue input pixel was assigned a minimum output value by default). It will be noted that although such probable errors are "calculated" pixel-by-pixel (based entirely on the tonal value of the pixel) and accumulated or stored in the shift register, they are not "accumulated errors" in the conventional sense applicant uses the term because they are ***not*** subject to being "***re***calculated" as additional conversion errors appear.

A sixth type of halftoning system error is ***"random error."*** It is known in the halftoning art to randomly vary the threshold value between two or more different values thereby introducing random error into the input/output conversion (comparing) step. This is done, as Kakutani explains, so that input pixels of regularly varying value or tone ("exceptionally systematic data") don't produce "regular pattern" artifacts (see Kakutani; column 15, lines 16-25). As noted above, Kakutani, in fact, argues that such a system, that is, one using a randomly varying threshold, introduces "exceptionally high noise" (column 2, lines 40-63) in distinction to its own system where the threshold is confined to the limits defined by equation 6. Actually, Kakutani is willing to introduce a little random noise (a "maximum" of +/- 6 over a 0-255 tonal range, see column 11, lines 58-61; see also generally column 15, lines 16-25) but cautions that "it is good" if the threshold value is confined to the range given by Equation 6 (implying that even this small amount of noise can take the threshold outside this desired range) and notes that such noise is not needed for "natural" images having even "moderate unevenness" (column 15, lines 23-26).

A good example of the "regular pattern" artifacts described by Kakutani is shown in FIG. 2 of Ostromoukhov (note the "checkerboard artifact" at the 1/2 level as also described, in Ostromoukhov, at column 2, lines 19-26). Ostromoukhov attempts to eliminate such artifacts by selecting different "threshold masks" (FIG. 7) for the input/output conversion (comparing) step, where each mask generates a variable threshold value that randomly varies between three different values (FIG. 10 shows a graph that depicts, as a histogram, the probability of the lower, middle, or upper value being generated).

In the section of the Action dealing with obviousness rejections, the examiner suggests combining Kakutani and Ostromoukhov. However, in Ostromoukhov, at integer fractions of the full tonal range, the random error is increased (see FIG. 11) by increasing the distance "d" between the upper or lower value and the middle value (FIG. 10) far beyond any threshold limit compatible with Kakutani (e.g., at a pixel value of 127, equation 6 of Kakutani would confine the threshold, slsh, to a range between 127 and 127.5 whereas Ostromoukhov would allow the threshold to vary between 128 +/- 50). Indeed, the approach shown in Ostromoukhov, where the threshold is randomly varied widely about a center value, is very similar to that shown in unexamined Japanese Patent Application (Hei. 1-130945) that Kakutani specifically considers and rejects. If one were to modify the Ostromoukhov approach so that d were limited to a "maximum" of +/- 6 (versus +/- 50 as shown in FIG. 11) and the center value were defined by Kakutani's equation 1 (versus being automatically set at 1/2 the full tonal range as shown in FIG. 10 of Ostromoukhov), the Ostromoukhov approach would then be compatible with Kakutani (see paragraph above). However, Kakutani itself already incorporates this approach (column 15, lines 15-20) so the suggested combination essentially adds nothing to that already described in Kakutani.

Applicant's system does not use randomly varying or even regularly varying threshold values but is still able to control "regular pattern" artifacts (see paragraphs 0021, 0022, 0026, and 0032 of applicant's corresponding U.S. Pat. Pub. 2002/0196484 A1). It does this by selecting at least one predetermined threshold value based on at least one accumulated error value. Accordingly, applicant's system is also not affected by the type of degradation in output quality that comes from introducing "random" or "excessive noise" (the initial fixed threshold, I_A,

preferably applied in applicant's system also contributes to retaining sharp edges and fine details, see paragraphs 0025 and 0032).

Based on the foregoing survey, applicant has amended each of the independent claims. This includes independent claim 20 (although such claim has already been shown to define over the Kakutani reference cited). These amendments are intended to clarify two points: 1) that the term "accumulated error" refers specifically to an error "subject to recalculation pixel-by-pixel" (e.g., not an average or probable error; here the term "recalculation" is just a more precise way of saying "accumulation"); and 2) that each threshold selected is a "predetermined" threshold (e.g., is not a "random" or "variable" threshold, even one randomly or variably chosen from a limited selection of predetermined thresholds). Referring to applicant's corresponding published U.S. Patent Application 2002/0196484 A1, support for these clarifying amendments can be respectively found at 1) paragraphs 007, 0024, and FIG. 2; and 2) paragraph 0027 and FIG. 4.

b. <u>Examiner's specific rejections for obviousness</u>

There are four independent claims currently pending: claims 1, 5, 12, and 20. In the action, the examiner rejects claims 1-4 and 12-18 under 35 U.S.C. § 103 as being obvious over Kakutani (U.S. Pat. 5,553,166) in view of Satou (U.S. Pat. 5,159,471) and Ostromoukhov (U.S. Pat. 6,356,362 B1). Claims 5-11 were similarly rejected, but with Ostromoukhov omitted. Dependent claim 19 was similarly rejected, but with Harrington (U.S. Pat. 6,072,591) added. Claim 21 (depending from independent claim 20) was rejected as being obvious over Kakutani in view of Zlotnick (U.S. Pat. 6,351,566 B1). It will be recalled that independent claim 20 (and, for that matter, its dependent claim 22) was rejected for anticipation by Kakutani, which rejection was addressed in the first part of this Amendment, and the reasons there given supporting allowance of claim 20 apply with equal force to claim 21. This summarizes the examiner's specific rejection of each pending claim.

In rejecting independent claim 1, the examiner states (near the bottom of page 4 while discussing paragraph (a) of that claim) that Kakutani discloses

> "...selecting a first intensity threshold...if a said accumulated error of a current pixel and a neighboring pixel ...exceeds a first error threshold...."

Likewise, in rejecting independent claim 5, the examiner states (near the middle of page 15 while discussing paragraph (c) of that claim) that Kakutani discloses

> "...selecting a first intensity threshold...if at least one of said current said accumulated pixel error and a neighboring said accumulated pixel error is less than an error threshold...."

Similarly, in rejecting independent claim 12, the examiner states (starting at the bottom of page 8 while discussing paragraph (c) of that claim) that Kakutani discloses

> "...selecting a first intensity threshold...if at least one of said current pixel accumulated error and an immediate neighboring pixel accumulated error is less than a first error threshold...."

For a number of reasons, applicant respectfully disagrees that Kakutani discloses selecting an intensity threshold based on at least one accumulated error. The most basic and fundamental reason is that when the examiner uses the term "accumulated error," what the examiner is truly referring to is the "average binary coding error" that is shown, for example, in FIGS. 5 and 6 of Kakutani. As applicant points out in the survey section above, this "average binary coding error" is not an "accumulated error," at least not in a conventional sense. Conventionally, an "***accumulated error***" is diffused error identified with a particular pixel which is subject, moreover, to being ***recalculated*** (accumulated) for that particular pixel (e.g., on a ***pixel-by-pixel*** basis) as further conversion errors appear. On the other hand, the "***average binary coding error***" referred to in Kakutani, as explained above, is normally ***calculated*** as the running average of the conversion error ***without continued reference to any particular pixel*** (or, at best, for a collective group of pixels). This average coding error, unlike applicant's accumulated error, does not provide an immediate, localized measure of prior conversion errors based on its localized value for the current pixel and, preferably, neighboring pixels. The average coding error is only meaningful as a long-term, system-level measure and, in fact, is only stable when the value of the input pixels are limited to a constant (recurring) value.

In applicant's last amendment dated July 13, 2006, applicant alluded to the one-to-one correspondence between an accumulated error and its corresponding pixel by adding claim language referring to the accumulated error of a "***selected one***" of a current pixel and a neighboring pixel (examiner's latest Action cited above refers to still earlier claim language).

Applicant has slightly amended this wording to more accurately refer to "***either one***" of these two pixels, but the implication remains the same. To further clarify that the term "accumulated error" is being used in its conventional sense, applicant has amended the claims to explicitly recite ***respective accumulated errors subject to recalculation*** (i.e, accumulation) ***pixel-by-pixel***. This distinguishes clearly, then, over the type of "accumulated error" (i.e., average binary coding error) relied on in the examiner's rejection.

Although the Kakutani system does, in fact, produce accumulated errors of conventional type (subject to recalculation pixel-by-pixel) for use in the traditional way (to augment or "correct" the current pixel), it refers to such errors as "the total error diffusion value total err (i,j)" (see Kakutani, column 9, lines 33-34). Kakutani does not disclose, as clearly required by currently amended claims 1, 5, 12, and 20, using at least one such accumulated error (i.e, "***subject to recalculation pixel-by-pixel***") for "selecting" a conversion "threshold" based on such accumulated error. Nor, for that matter, does Kakutani disclose selecting a conversion threshold that is "***predetermined***", as also clearly required by currently amended claims 1, 5, 12, and 20. Indeed, even if we were to accept the logic used by the examiner in the Action and presume, for example, that some manner of accumulation error linearly relates directly to the input pixel value, the threshold, Slsh, under equation 1 of Kakutani would then change for each change in accumulation error and no one "predetermined" threshold would generally be selected even if, for example, a particular error threshold is met. As currently amended, then, it is submitted that independent claims 1, 5, 12, and 20 patentably define over the references cited and thus stand, together with their corresponding dependent claims, 2-4, 6-11, 13-19, and 21-22, in present condition for allowance, which action is respectfully requested.

Even apart from the present clarifying amendments, however, each claim patentably defines over the reference or combination of references cited against it in the current Action. For example, without reference to such amendments, applicant already established, in the first part of this Amendment, that independent claims 20-22 patentably define over Kakutani. As will now be established, the same holds true for the remaining claims (claims 1-19), which were rejected for obviousness over various combinations of references.

Leaving aside claim 21 for the moment (which is allowable, in any event, being based on allowable claim 20), every other claim rejected for obviousness in the Action (claims 1-19) was

rejected based on some combination of Kakutani in view of Satou as also viewed with, for certain of the claims, Ostromoukhov (claims 1-4 and 12-18) or Ostromoukhov and Harrington (claim 19). In proposing this core combination of Kakutani and Satou, the examiner states the following:

> "At the time of the invention, it would have been obvious ...to select a first intensity threshold based on a selected one of a current pixel and a neighboring pixel, as taught by Satou, wherein the selection of said intensity threshold is specifically based on the accumulated error, as taught by Kakutani. A suggestion for doing so would have been that the intensity threshold is based on the pixel values in Satou, and Kakutani teaches that the accumulated error is a function of the pixel value (figures 5-6 of Kakutani). A further motivation...to increase printing/transmission speed...."

(see the paragraph starting at the bottom of page 6 in the section rejecting independent claim 1, the bottom paragraph on page 16 in the section rejecting independent claim 5, and the top paragraph of page 11 in the section rejecting independent claim 12).

Reduced to its essentials, the logic supporting the combination of Kakutani and Satou appears to be based on three underlying propositions:

1) threshold selection can be a function of pixel intensity, more specifically, of two pixel intensities corresponding to the current and neighboring pixel as taught by Satou;
2) the accumulated error is a function of pixel intensity as taught by Kakutani; and therefore this suggests
3) threshold selection can be a function of accumulated error, more specifically, of two accumulated errors corresponding to the current and neighboring pixel.

For reasons soon to be made clear, applicant disagrees with this logic.

Concerning the first proposition, applicant would agree to the extent that Satou shows a halftoning system in which threshold selection is a function of pixel intensity, more specifically of two pixel intensities corresponding to the current and neighboring pixel. In the respective embodiments of FIG. 7 or 11 of Satou, we find a selection device (30 or 55) that selects either a high threshold (A) or low threshold (B) output for the current pixel depending on whether the

pixel intensity of either the pixel immediately above (FIG. 7) or the three closest pixels above and the last pixel (FIG. 11) have probable error identified with their output. As explained in the survey section above, a pixel has probable error identified with its output if the pixel input is neither above the high threshold (A) nor below the low threshold (B) (so as to be "close enough" to the high or low output) but rather is in the midrange (so that a probable error exists between the midrange input and the low, as selected by default, output). Actually, Satou uses the term "intermediate data=1" and not "probable error" as such; however, such term is more descriptive and clarifies Satou's approach. To summarize, then, it is correct to say that Satou shows threshold selection based on two input pixel values corresponding to two probable error values. (Satou's FIG. 13 embodiment, also referenced by the examiner, does not actually show threshold selection but instead shows output conversion directly by table lookup by device 86 based on the input values of the current and two neighboring pixels, each value being roughly represented by a two-bit (4 value) data string or probable error indicator).

However, basing threshold selection on ***probable error*** values, as shown in Satou, is entirely different than basing it on ***accumulated error*** values, as claimed, because the two types of errors are entirely different. Probable error is roughly based on the input pixel intensity only. Conventional accumulated error, on the other hand, is precisely based on the input/output difference in pixel intensity and reflects, moreover, further localized occurrences of such difference (or conversion error) through pixel-by-pixel recalculation or accumulation.

In considering the first proposition above, the broader question is not just what Satou shows, but whether what Satou shows is properly combinable with Kakutani; it is, after all, this particular combination that is being proposed. Referring to equation (1) of Kakutani (see column 8, line 33), would one be motivated, based on Satou, to make the threshold value of Kakutani not just a function of the current pixel intensity, data (i,j), but also a function of a neighboring pixel intensity, say data (i-1,j)? Given that Kakutani seeks to limit the range of variation in threshold value for a given current pixel value (to that prescribed by equation 6; see column 12, lines 12-20), this would strongly suggest the answer is no. At the very least, before giving an answer, we would need to repeat the "experiments" that Kakutani conducts in constructing FIGS. 5 and 6, this time for data along two horizontal axis (say x and z) to find out whether the "average binary coding error (along the vertical axis y) can be kept below 50 or whatever new level is needed to

prevent "tailing" (column 12, lines 3-20). In other words, at least some level of experimentation, if not an undue level, would be required just to determine if the proposed modification suggested by Satou provides any real advantage (to offset its clear drawbacks) in the context of Kakutani. Let us ignore this difficulty with the first proposition, however, and pass on to the second.

The second proposition underlying the proposed combination is that accumulated error is a function of pixel intensity as taught by Kakutani (the examiner refers to FIGS. 5 and 6 of Kakutani in support of this proposition). There are at least three problems with this second proposition, not the least being that FIGS. 5 and 6 refer not to "accumulated error" but to "average binary coding error." As explained above, the "average binary coding error" is not an "accumulated error," at least in the conventional and claimed sense of the latter term. Indeed, the "average binary coding" error is more closely related to a "conversion" error than an "accumulated" error (see the brief survey section under heading "a" above).

Accumulated error is a localized error that changes based on respective instances of conversion error. It accounts for these conversion errors instantly and remains valid for natural images. "Average binary coding" error, on the other hand, is a system-level error normally computed as a running average of the conversion (binary coding) errors. As used in Kakutani, it only has significance (conforms to the relationship shown in FIGS. 5 and 6) when evaluated over the long-term after a sufficient string of input pixels of constant or recurring value have been evaluated. As noted earlier in this Amendment in the first section discussing anticipation of claim 20, if the value of the pixel string changes to a new value, the average binary coding error will drift in time to a new stable value (FIGS. 5 and 6 only report this stable value). Thus, it is at least misleading to say that the average binary coding error of FIGS. 5 and 6 is a function of pixel intensity without also mentioning it is a function of time (the second problem; note that if the second proposition is a function of pixel intensity and time, the third proposition generally fails). And even with this proviso, the linear relationship shown in FIGS. 5 and 6 only holds under special conditions where the intensity of each input pixel is a recurring value or constant (the third problem; note that such condition is generally not the case, e.g., with a "natural" image). To say, then, that accumulated error is a function of pixel intensity, as the second proposition does, is generally incorrect.

The third proposition underlying the proposed combination is drawn from the first two. Because the first two propositions are invalid for the proposed combination, so too is the third. An easy way to see this is to substitute "average binary coding error" for "accumulated error" in the third proposition. The third proposition then becomes: threshold selection can be a function of average binary coding error, more specifically, of two average binary coding errors corresponding to the current and neighboring pixel. This is nonsense because average binary coding errors are not calculated pixel-by-pixel. Moreover, the average binary coding error is only a result in Kakutani and not a cause or control used to select thresholds.

To select its "thresholds," Kakutani uses the current pixel intensity. Satou uses its probable errors (which are really just a rough measure of pixel intensity). Even if Kakutani were combined with Satou, it is still pixel intensity (or intensities) that would be used to select the thresholds. To briefly consider the other references relied on in the rejections for obviousness, neither Ostromoukhov, which extends the pixels considered to "remotely neighboring" pixels; nor Harrington, which compares various sums and differences of the color component of the current pixel to four fixed thresholds (labeled ONE, TWO, THREE, and Graybias); nor Zlotnick, which is essentially a probable error system like Satou, as further described below; suggests any modification that would change this result. None of these references suggest using at least one accumulated error for selecting a threshold, as claimed. While it is true that threshold selection can be a function of accumulated error, more specifically, of two accumulated errors corresponding to the current and neighboring pixel, this result is to be found in applicant's claims 1-19 and not in any of the corresponding proposed combinations.

Based on the foregoing, it is submitted that independent claims 1, 5, and 12 patentably define over the corresponding combinations proposed in the Action, that the rejection of these claims for obviousness is therefore overcome, and that these claims, together with their respective dependent claims 2-4, 6-11, and 13-19, presently stand in condition for allowance, which action is respectfully requested.

Dependent claim 21 is the only claim in the Action that was not rejected for obviousness over some combination including both Kakutani and Satou. Instead it was rejected for obviousness over Kakutani in view of Zlotnick. Before considering this particular obviousness

rejection, applicant will briefly review the obviousness rejection of certain of the other dependent claims.

Dependent claims 2, 6, and 13 are related insofar as each requires at least one error threshold that is substantially zero error. Each corresponding independent claim requires that a respective accumulated error be compared with each error threshold for selecting the intensity (i.e., conversion) threshold. In rejecting these claims, the examiner seems to be saying that Kakutani discloses selecting the intensity threshold to provide an error threshold that is substantially zeroed. This confuses cause and effect. In fact, the relevant question is whether Kakutani (in combination with Satou and, for claims 2 and 13, also with Ostromoukhov) discloses providing an error threshold that is substantially zero to select the intensity threshold. To answer the question just posed, Kakutani doesn't select a threshold based on an accumulated error, doesn't provide an error threshold to compare with such accumulated error, and doesn't set such error threshold to substantially zero error (nor are zero error thresholds disclosed in Satou or Ostromoukhov). Claims 2, 6, and 13, then, patentably define over the corresponding references cited even apart from their respective independent claim and, thus, separately stand in condition for allowance, which action is respectfully requested.

Dependent claims 3, 9, and 16 are related insofar as each requires, in conjunction with their corresponding independent claim, selecting a first or second (or possibly other) intensity threshold when the corresponding error threshold is met such that the first threshold is greater than the second. In considering each dependent claim, it is rightly the proposed combination of Kakutani as modified by Satou that should be considered (i.e., the same combination cited against the independent claim) and not just what Kakutani shows prior to modification. This important principle, though seemingly overlooked, applies to the other dependent claims as well.

Let's say we modify equation 1 of Kakutani (column 8) in view of Satou so that the first threshold, Slsh, is a function of both the current pixel intensity, data(i,j), and the neighboring pixel intensity, data (i-1,j). Following the examiner's lead (see quoted text and related proposition 2 on pages 20-21 above), assume the accumulated error is a function of pixel value. As an example, let's assume that when both input pixel values exceed 240, the accumulated error meets the first error threshold and that the current and neighboring pixel values are presently 241 and 241. From modified equation 1, we then find the **first** threshold, call it T1. What happens,

now, if the current and neighboring pixel values change to 245 and 245? Under modified equation 1, we have now selected a **second** threshold, call it T2 and, even though the assumed first "error threshold" is still met, have deselected our first threshold, T1, contrary to claims 3, 9, and 16. Moreover, if we assume thresholds increase as pixel values increase (see FIG. 7 of Kakutani or the clause starting on the second to last line of page 13 of the Action) our second threshold, T2, is greater than our first threshold, T1, not less than, as required by claims 3, 9, and 16. What happens, now, if the current and neighboring pixel values change to 239 and 255? Now, even though the assumed first error threshold is **not** met, we have now selected a **third** threshold (possibly equal to the second), which again is greater than our first threshold, T1. The point here is that once we modify Kakutani in view of Satou to introduce two pixel values, there really is no relationship between pixel thresholds and any discernible error thresholds. Accordingly, claims 2, 6, and 13, have been shown to patentably define over the corresponding references cited even apart from their respective independent claim and, thus, separately stand in condition for allowance, which action is respectfully requested.

This brings us back to dependent claim 21, which was rejected for obviousness over Kakutani in view of Zlotnick. Dependent claim 21, when read together with its base claim 20, requires an initial thresholding unit for comparing the current pixel to an initial threshold where this initial threshold is greater than another threshold selected "in response to" at least one accumulated error. Zlotnick does show comparison of the current pixel with an initial threshold (actually two initial thresholds, T-D/2 and T+D/2) but none of its noninitial thresholds (Average-D, Average+D, or T) are selected "in response to" at least one "accumulated error."

Zlotnick, like Satou, is really just another type of "probable error" system where the high-enough value and low-enough value input pixels are immediately converted (by comparison with the initial thresholds) to high and low outputs (because the difference between input and output is deemed close enough). The remaining midtone input pixels are generally assigned outputs reflecting the number of neighboring midtone pixels or amount of "probable error" (unless the midtone input pixel approaches the exact halftone value). For example, referring to FIG. 6 of Zlotnick, the greater the number of neighboring midtone pixels, the higher both the Average and the probable error (with WHITE the default output), the greater the chance of the current pixel being < Average-D and selecting BLACK (or, conversely, the lower the chance of the current

pixel being >Average+D and selecting WHITE). In other words, the noninitial thresholds (Average-D and Average+D) are selected "in response to" probable error (based roughly on pixel intensities) and not in response to at least one accumulated error (based precisely on accumulated conversion errors), as claimed.

If we attempt to modify the primary reference, Kakutani, to consider the average intensity of neighboring pixels, as shown by Zlotnick, we run up against the same type of problems encountered in combining Kakutani and Satou. Not the least of these is how to restrict the threshold selected by equation (1) of Kakutani such that, as taught by Kakutani, the threshold stays within the carefully confined range defined by equation (6), while, at the same time, making such threshold dependent on plural pixel intensities (which naturally vary widely). Kakutani is particularly concerned about confining the threshold at input data values 1, 2, 253, and 254 (column 12, lines 35-37 and column 14, lines 25-28 of Kakutani), which are exactly those values where Zlotnick applies its initial thresholds because the output is "close enough." Even ignoring this problem, the resulting combination would still only show selection of the noninitial threshold based on pixel intensities or probable errors and not based on at least one accumulated error, as required by claim 21. Accordingly, claim 21 patentably defines over the proposed combination, even apart from its allowable base claim (claim 20), and therefore separately stands in condition for allowance, which action is respectfully requested.

III. Conclusion

To summarize the remarks above, a background survey has been included (in section IIa) reviewing different types of errors possible in halftoning systems and two clarifying amendments have been made . It has been shown (in section IIb) that independent claims 1, 5, 12, and 20, and therefore their respective dependent claims 2-4, 6-11, 13-19, and 21-23, patentably define over the various references particularly in view of these clarifying amendments. It has been shown (in section I) that even without these amendments, independent claim 20, and therefore its dependent claims 21-22, patentably defines over Kakutani. It has been shown (in section IIb above) that even without these amendments, independent claims 1, 5, and 12, and therefore their respective dependent claims, 2-4, 6-11, and 13-19, patentably define over the various combinations proposed. It has been shown (in section IIb above) that even without these

amendments, a first group of related dependent claims, claims 2, 6, and 13, a second group of related dependent claims, claims 3, 9, and 16, and also an individual claim not grouped, claim 21, patentably define, even apart from their allowable base claim, over the various combinations proposed.

In view of such remarks, it is submitted that all of the currently pending claims, claims 1-22, patentably define over the cited art. Accordingly, applicant would respectfully request reconsideration of the previous Action and allowance of claims 1-22.

Respectfully submitted

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Dated: November 6, 2006 By ______________________

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I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on November 6, 2006.

Dated: November 6, 2006 ______________________
Kevin L. Russell